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COMBINED EFFECT OF HVDS AND RECONDUCTORING IN DISTRIBUTION FEEDER POWER LOSS MINIMISATION

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ABSTRACT

This paper presents a method to minimise the technical losses in distribution systems. The high voltage distribution system along with reconductoring is proposed to minimize the technical losses in distribution feeder. The proposed methodology is compared with HVDS method of distribution system loss reduction. The comparison reveals that using reconductoring with HVDS, the distribution feeder losses reduce to a significant amount as compared to HVDS method alone. The analysis is performed in CYMDIST. The developed methodology is carried on single distribution feeder and can be extended to a distribution network consisting of number of such feeders.

KEYWORDS: HVDS, Reconductoring, LT Lines, HT Lines, Distribution System Losses, CYMDIST

INTRODUCTION

The distribution system is the most vital part of the supply chain and is at the centre of the power industry deregulation. It assumes great significance as it has a direct impact on the efficient operation of the power system as a whole. It is of great concern for the consumers as it is the link which provides electricity to the end users. Therefore a larger part of the total investment on power system is utilized by the distribution network. Despite of this, the condition of the distribution network is not at par level. Ideally the T&D losses in any electrical system should be around 3 to 5%. But in India T&D loss is around 25% to 30% in which distribution loss has a considerable part alone. This is due to a number of reasons such as poor health of conductor and equipments, improper load management, too many transformations, improper planning for load growth etc.

In order to reduce the distribution network losses a number of methods has been adopted such as network reconfiguration, DTC relocation, network reconductoring, implementation of HVDS, load management etc. Since the load on a distribution network increases gradually with the passage of time, therefore proper forecasting of load is very important. This will help in proper planning of the distribution network to meet different future loads and hence reduce the distribution network loss. Proper planning for the up-gradation of existing distribution network needs more attention as the unpredictable nature of load growth impacts the operation and performance of the distribution network. In order to improve the performance of the network one needs to analyze the existing distribution network and optimize them such that they can cater the future load with high reliability and decreased losses.

A number of works has been carried out to reduce losses in distribution systems mainly in the perspective of active power loss reduction since the cost of MW loss occupies considerable amount of operating cost in the system. Therefore, a small amount achieved from loss reduction is still attractive for electric power utilities. Feeder reconfiguration, optimal capacitor placement DTC relocation, distributed generation implementation etc are some of the methods for distribution loss reduction [1] on which a number of work has been carried out. Merlin et al. [2] was the first to propose feeder reconfiguration for loss minimization. He used a discrete branch and bound technique for feeder reconfiguration.

However, this method involves approximations. To overcome these approximations, Shirmohammadi et al. [3] proposed an efficient algorithm for feeder reconfiguration. Distribution loss reduction by reactive compensation using capacitor placement was proposed by Baran et al. [4,5] and Haque [6]. Peponis et al [7] and Dong Zhang et al. [8] have developed a methodology for the optimal operation of distribution network in which loss minimization is obtained by installation of shunt capacitors as well as reconfiguration of the network simultaneously. Davidson et al. [9] have presented an optimization model for loss minimization in distribution network with distributed generation. Minimization of losses in distribution feeder using HVDS concept [10,13] is presented by Amaresh et al.[11]

The main contribution of this paper is to present and compare different approaches for feeder restructuring in balanced loading distribution systems with the objective of power loss reduction. It employs HVDS and feeder reconductoring in order to reduce the distribution loss. The network losses are analysed using CYMDIST [12]. The data for the purpose of analysis is taken from[13]

HVDS AND RECONDUCTORING

High voltage distribution system is a practice where low voltage lines are replaced with high voltage line upto the load point thereby giving a number of advantages. This conversion of low voltage system into high voltage reduces the distribution losses effectively and hence increases the system efficiency. Another method of reducing the distribution loss is network reconductoring. Reconductoring is a practice in which the existing conductor on the feeder is replaced with an optimal conductor size for optimal length of the feeder. The existing conductor of the feeder is no more optimal due to rapid load growth and since size of the conductor is the parameter which decides current density and resistance, therefore it is a cause of inefficient operation of the system. Reconductoring of network depends on load expected to serve and the capacity required to serve in future. Therefore it increases the capability of the system to handle load growth.

ALGORITHM

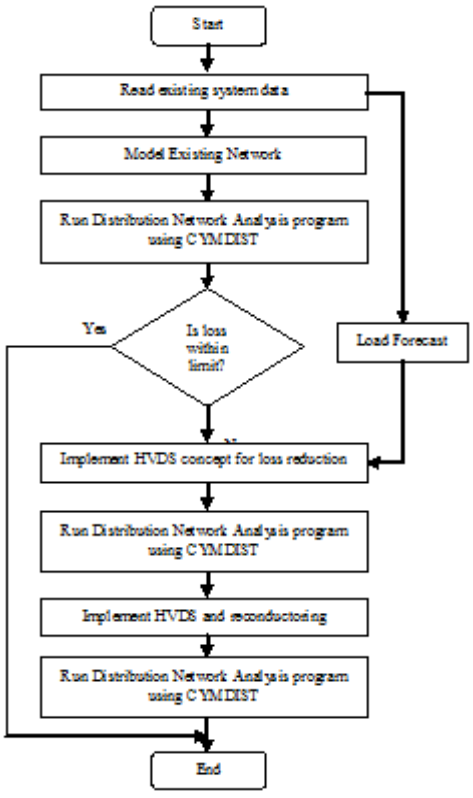

Figure 1: Flow Chart for Distribution System Loss Reduction

The algorithm adopted in the paper is shown in flowchart Figure 1. The algorithm adopted in [13] is modified in this paper in which we have considered the HVDS along with reconductoring and also considered the impact of load growth on distribution feeder.

The power flow analysis on distribution feeder is carried out to evaluate the losses for the specified load conditions. First the power flow analysis is performed for the existing feeder and then for two cases of modified network. The results are compared in order to check out the efficiency of the proposed methods.

TEST CASE

As a test case, the same feeder as evaluated in [13] is taken which consists of 11KV feeder starting from substation to the LT consumers and feeding to 89 Distribution transformers. The peak load of feeder is 200 amperes its length about 76km. The adaptation of proposed scheme to the existing feeder along with the load growth for two years is considered.

The assumptions made for the purpose of network study are same as considered in [13]. An extra assumption of voltage limit of ± 6% is considered here in power flow analysis of the distribution feeder.

SIMULATION RESULTS

The power flow analysis of the distribution feeder is carried out to calculate the technical losses in three different cases under specified load conditions.

Since there is a continuous load growth on distribution network, therefore an annual load growth of 5% on existing feeder is also considered here and power flow study for forecasted load growth for two years is also carried out in order to know the effect of laod growth on distribution feeder.

Existing Distribution Feeder Analysis

The power flow analysis results for the existing system are shown in table 1 and table 2. The analysis is carried out under full-load condition for the present system and the system after two years.

Table 1: Existing Distribution System Analysis

	Present	After 2 Years
Total Load (KW)	3,226	3,590
Power factor	0.85	0.85
Total Loss (KW)	428	540
	13.3%	15.0%

The LT and HT line losses are separated for the existing feeder and are shown in table 2.

Table 2: Existing Distribution System LT and HT Loss

	Present	After 2 Years
Total Load (KW)	3,226	3590
Total Loss (KW)	428	540
Total LT Loss (KW)	220	278
Total HT Loss (KW)	208	262
% LT Loss	6.9%	7.7%
% HT Loss	6.5%	7.3%

The analysis shows that presently the loss on existing feeder is high and it goes on increasing as the time passes as shown in Figure 2.

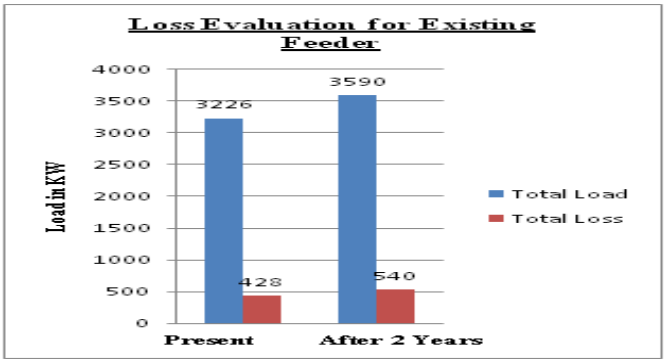

Figure 2: Graph Showing Total Load and Total Lossesin Existing Feeder

Analysis of Feeder after Implementing HVDS

The power flow analysis results after implementing HVDS scheme to the existing system are shown in table 3 and table 4.

Table 3: HVDS Analysis

	Present	After 2 Years
Total Load (KW)	3,226	3,590
Power factor	0.85	0.85
Total Loss (KW)	261	330
	8.1%	9.2%

Table 4: HVDS LT and HT Loss

	Present	After 2 Years
Total Load (KW)	3,226	3590
Total Loss (KW)	261	330
Total LT Loss (KW)	134.65	170
Total HT Loss (KW)	126	160
% LT Loss	4.2%	4.7%
% HT Loss	3.9%	4.5%

The power flow analysis after implementing HVDS scheme shows that a good amount of loss is reduced even considering load growth forecast as shown in Figure 3.

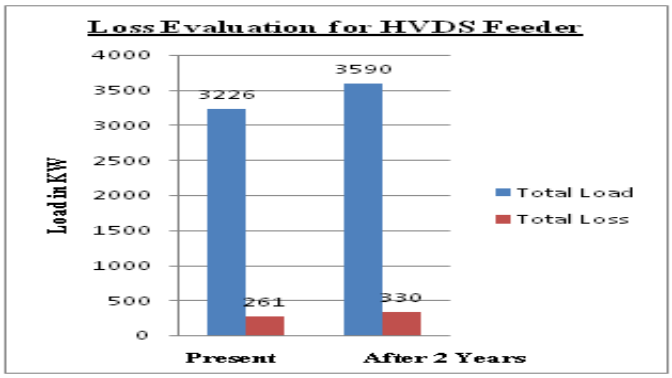

Figure 3: Graph Showing Total Load and Total Lossesin HVDS Feeder

Analysis of Feeder after Implementing HVDS and Reconductoring

The power flow analysis results after implementing HVDS and reconductoring to the existing system are shown in table 5 and table 6.

Table 5: Proposed HVDS and Reconductoring Analysis

	Present	After 2 Years
Total Load (KW)	3,226	3,590
Power factor	0.85	0.85
Total Loss (KW)	233	295
	7.2%	8.2%

Table 6: Proposed HVDS and Reconductoring LT and HT Loss

	Present	After 2 Years
Total Load (KW)	3,226	3590
Total Loss (KW)	233	295
Total LT Loss (KW)	120	152
Total HT Loss (KW)	113	143
% LT Loss	3.7%	4.2%
% HT Loss	3.5%	4.0%

The analysis of the distribution network after implementing HVDS and reconductoring proposal shows that there is significant reduction in distribution line losses as shown in and Figure 4.

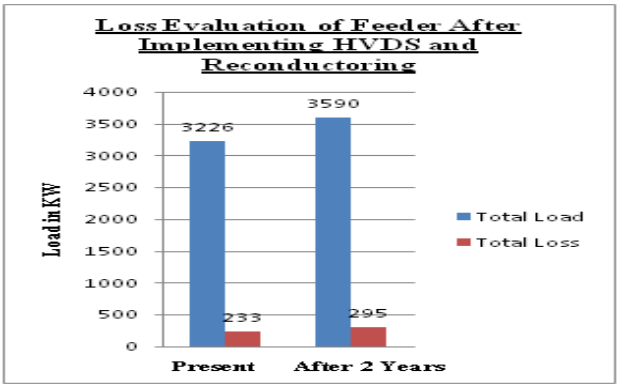

Figure 4: Graph Showing Total Load and Total Lossesin Feeder after Implementing HVDS and Reconductoring

A loss comparison of the three different cases shows that by implementing HVDS scheme the loss on the existing distribution system reduces to a significant amount which is further reduced by implementing reconductoring along with HVDS scheme as shown in Figure 5.

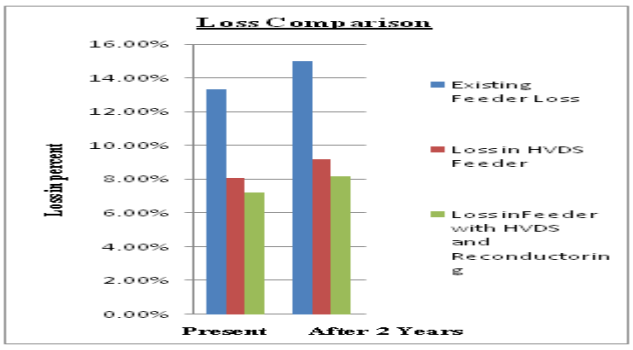

Figure 5: Graph Showing Percentage Loss in Feeder in Different Cases with and without Load Forecasting

CONCLUSIONS

An HVDS scheme together with reconductoring has been discussed in this paper in order to minimize the distribution loss. The power flow study calculates the losses in the existing distribution feeder and hence a comparison of

the implementation two different methods to the same feeder is carried out in order to reduce the loss in existing feeder. The power flow study is also carried out with load forecasting for two years and the losses in the feeder for different cases with this load forecasting are calculated. The proposed HVDS along with reconductoring shows that there is a significant reduction of loss in distribution feeder after impleneting it. The same method can be applied for proper planning and reduction of loss in bigger distribution network.

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